Progress Report

Wyoming Geographic Information Project

Lisa Warnecke, September 9, 1985

I. Executive Summary

Approximately six months ago, with a seasonal decrease in my work as a budget analyst, I began an informal investigation of geographic information usage and coordination in Wyoming. Based on my experience in local government management and information technology, I was convinced of the value of spacially-referenced databases and analysis tools. Serving as a budget analyst for Wyoming's natural resource agencies, it appeared that the State could benefit by multiple use databases and recently improved automated techniques to reduce costs and duplication, and increase the value and effectiveness of information for project specific, agency and Statewide decision-making. Through various contacts and referrals, I learned about past and current Wyoming projects, resources and efforts to improve geographic information usage and coordination between State, federal and local agencies, as well as the business and educational communities. An inventory of geographic information systems (GIS) usage in other states and governments was begun, as well as a review of recent technological capabilities. I developed a survey of geographic information usage and needs which was distributed by the State Planning Coordinator's Office to representatives of relevant State, federal and local agencies, the University of Wyoming and some private sector representatives. During my analyses, I contacted and gathered some relevant State employees together to advise me and also held some meetings for purposes of education, survey review and project updates.

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III. Audit of In-State Activities

A. Historical Review

With help from Dick Hartman, State Planning Coordinator; Collin Fallat, Department of Agriculture; George Christopulos, State Engineer; and Mike O'Grady, Water Development Commission; as well as other State employees, I was able to learn about geographic information, mapping and remote sensing activities and coordination attempts in the State of Wyoming. A State Mapping Advisory Committee (SMAC) was organized over thirty years ago with George Christopulos, now State Engineer, serving as Secretary of the group since before 1960. This group has had inactive and active periods, but has not had an official meeting for over five years and reference was deleted from the statutes in 1982. As shown in a report published in October, 1974, for the Wyoming Land Use Commission and through some activities of Collin Fallat and Lenore Deham at the State Planning Coordinator's Office, efforts were made to analyze land use in Wyoming through an interagency approach. A National Cartographic Information Center (NCIC) providing USGS information was established in the State Engineer's Office in 1979. More recently, through the efforts of some of these same individuals, presentations and information exchange meetings were held both in 1981 and 1982. The last known meeting regarding geographic information was held on December 10, 1982, with representatives of both State and federal agencies in attendance reporting on their mapping, photography and remote sensing activities. According to attendees, interest was expressed to continue having meetings, however, a project, focal point or staff did not exist in order to support continued meetings.

B. Agency Contacts and Projects

During the last six months, I have contacted almost all State agencies that work with geographically based information. These agencies include the State Highway Department, Game and Fish, DEQ, Revenue and Taxation, Industrial Siting, Recreation, State Engineer, Oil and Gas, State Geologists, Public Lands and Forestry, DEPAD, Disaster and Civil Defense, DAFC, Water Development Commission, Agriculture, Health and Social Services, Archives, Museums and Historical, State Planning Coordinator's Office, and the Water Research Center and the Cartography Department of the University of Wyoming.

These contacts revealed a great deal of useful resources. Photography provided by the State Highway Department and Water Development Commission is used by a variety of State agencies and consultants. Mapping programs are being conducted by the Highway Department, Public Lands,

State Geologist, Agriculture, Revenue and Taxation and other agencies. Geographically based databases include a variety of manual systems, and some automated systems existing on Data Services' mainframe computer or microcomputers. This initial review revealed a variety of useful systems, and the desire of many State agency representatives to communicate and coordinate with each other.

C. Geographic Information Survey

Based on the advice of some State employees, I prepared an initial draft survey of geographic information projects and needs during May. With the help of approximately twenty State employees at a survey review meeting on June 26, Paul Cleary and Jeff Allwood of the State Planning Coordinator's Office, and myself were able to repeatedly edit and create a final survey document. In August, this survey was sent to all relevant State and federal agencies, as well as some representatives from Wyoming's local governments, university departments and the private sector. It is anticipated that the survey results will be entered into a microcomputer for tabulation and initial analysis, with a State wide meeting of respondents planned sometime in October. The survey was designed to give an overview of activities with a follow up survey, oral interviews, or other mechanisms necessary to provide a complete audit and basis for specific coordination activities.

IV. Audit of Non-State Government Activities

A. Federal Government

During this time, I have developed contacts with the Water Resources Division and National Mapping Division of the U.S. Geological Survey, the Bureau of Land Management, and the National Geodetic Survey of the National Oceanographic and Atmospheric Administration. These agencies provide all geodetic control, cartography and cadastral information from the federal government for the State of Wyoming. This work resulted in the discovery of funding possibilities through these agencies and the development of a coordinated approach between them and the State of Wyoming. The State was asked by the USGS and BLM to co-sponsor a State and federal geographic information exchange to be held December 3 in Cheyenne. These agencies expressed concern that the State needed to take a more assertive role in analyzing and coordinating geographic information and initiated the December 3 meeting to help stimulate some activity. My efforts have included working with them to achieve this goal. In fact, we have the potential to become a demonstration State to develop a multiple use GIS for a couple quadrangles.

My contact with the National Geodetic Survey, through the State Highway Department, resulted in learning about new conversions planned in geodetic references which will affect coordinate systems in the State. My efforts in this regard included organizing an initial education meeting with five State agency representatives on August 28. Based on their perceived importance of these changes, a second, more fully attended meeting is planned for late in September through the State Engineer's Office. Interested in assisting Wyoming in these conversions with potential funding possibilities, NGS's national office also suggested we could initiate a congressional bill for funding like the State of Louisiana.

An informal audit of federal agency activities has revealed the development of national data bases with or without State input or coordination efforts. For example, USGS's Mineral Resource Data System will include information about Wyoming's mineral locations and production without State involvement due to lack of funds. The State Geological Survey will be entering data into the National Coal Resource System, but plans have not yet been made to make this information accessible to other State agencies. Similar projects exist throughout State and federal agencies. Wyoming needs to develop its capability to ensure input, accessibility and usage of federally generated data as well as have an active role in policy and management of our State's resources.

B. Local Governments

Seven years experience in local government management has provided me with first hand knowledge of geographic information use. Utility management, tax collection, planning, zoning, building permits, police and fire dispatching, engineering, and other public works activities all employ geographically based information. Local governments in Wyoming have been using aerial photography provided by the State, and some have been involved in mapping activities through the Revenue and Taxation Department. According to this Department, a few counties are investigating the potential of developing a detailed, parcel based information system.

C. Private Sector

A brief analysis of private sector activities was also conducted. Exxon, Amoco and Phillips Petroleum Company are using computer based information systems, and Petroleum Information, Inc. has an extensive database which could be very useful to the State as a whole. In addition, electric, gas and telephone companies use geographic information on an extensive basis in order to manage and provide services. The private sector has not been an active participant in the State's geographic

information project to date. However, the survey should provide needed information about their projects and needs, and serve as a basis to include them and their resources in a geographic information coordination effort and resource base. A geographic information resource would also serve our efforts to improve public/private cooperation and provide a basis for economic development efforts. A system could provide information, siting location assistance, and market analyses for businesses, and a resource center could advise them of changes such as the National Geodetic Survey's new coordinate systems.

D. Other States

Most of my efforts investigating outside activities has focused on the use and analysis of geographic information in other states. During the last six months I have contacted and received specific application information from approximately half the states in the union and have received general information about some of the remainder. A summary of my preliminary findings and some conclusions based on other studies are provided below.

1. Purpose and Applications

The use of spacially-referenced databases, automation, and analysis tools has developed in appraisal projects, natural resources management, transportation systems, and more recently economic development efforts. Approximately forty states have some form of a natural resource information system, with almost as many utilizing automation for transportation and highway planning and design. These systems may or may not use geographic information systems technology, and few natural resources and transportation systems are integrated. Approximately five states have been found to use GIS technology for economic development efforts by merging natural resources and socioeconomic information with models and other analytical tools. I was unable to find a thorough inventory analysis of state transportation systems, however, like our State Highway Department, most are utilizing a system named Intergraph. State natural resource information systems have largely grown out of departments of natural resources, geologic surveys, and/or universities, with some originating in public lands or planning and research departments. The objective of these departments and systems has been to provide an information resource for public and private needs and a basis for State regulation efforts.

Examples of data sets within State systems include: agriculture, climate and weather, coastal and marine resources, cultural resources, energy resources and uses, environmental quality, fisheries, forestry, geology, ground and surface water, land use, land cover, natural diversity elements and

areas, natural disasters and hazards, recreation, soils, transportation, vegetation, wildlife, topography, ownership, and basic land grid information and reference points such as the public lands survey, latitude and longitude, state plane coordinates, etc. When merged with infrastructure, demographic, socioeconomic, zoning, industrial siting, and other planning data and information, an excellent basis for statewide planning and decision making can be developed as is shown in the most sophisticated applications.

2. Legal Framework and Organization

The earliest natural resource information systems, developed in the early 1970's, were designed to help states better manage their resources. These early systems largely originated in single agencies and then their usefulness was expanded to other agencies and purposes as needs arose. It appears that some newer systems have been developed with a multiagency approach. Executive orders and enabling legislation have been used to establish State Mapping Advisory Committees (SMAC) and other multiagency tasks force and committees to develop policies for the usage of geographic information within individual states. Though a variety of organizational approaches appear to work, each state has developed its own individual structure and applications. The growing need for information for executive and legislative level decision making, increasing numbers of databases, and vastly improving technological developments, suggest that a statewide, multiagency approach is preferred. In this way, specific data bases and information systems can be designed, managed and analyzed for project specific and agency uses, but also form components of an integrated information base for statewide policy development, planning, analysis and decision making.

3. Financial and Personnel Commitments

Development of integrated geographic information bases require an initial investment for planning, analysis and agency input to ensure maximum system effectiveness. Good quality manual systems are necessary prior to digitization of databases as input to an automated system. Cost for hardware and software to provide an automated geographic information system can run from $150,000 and up, but states have found their labor costs to gather and enter data can be much greater than this hardware and software commitment. Increasing availability of data such as digitized 7 1/2 minute maps provided by the USGS, and technological developments through the use of optical scanners rather than manual digitizers, can greatly reduce data input costs. General planning data can be entered with less labor costs than detailed information. States have prioritized data entry requirements accordingly and

used cooperative agreements to establish standards and methods for other entities to input data into a state system.

An inventory of other states found operating costs ranging from a couple of million dollars and staffs of up to forty persons such as Minnesota, to projects that are funded by less than $100,000 of general funds and less than five employees such as the State of Kansas. The difference between these systems are quite marked, as statewide information sources for multiple uses require a larger commitment than smaller, specific application programs that are in an evolutionary phase to a larger, statewide system. A variety of different funding schemes have been developed in different states. General funds were often used as start-up monies, and many states are now considering and implementing cooperative agreements with federal, and local agencies, and charge back systems for state agencies and other public and private users. The States of Illinois and Kentucky were able to develop geographic information systems within a short time frame and limited financial commitment because Office of Surface Mining Lands Unsuitable for Mining Program monies were utilized for initial capitalization and some operating expenses.

4. Success/Problems/Needs

States that have developed geographic information systems are quite satisfied with their efforts, implementation and development of data sets and applications. However, these systems require a constant dedication and level of effort. Changing the status quo and implementing information technology often results in resistance, but states have proven successful at including and convincing users of the usefulness of GISs. In fact, most states have upgraded their hardware in response to user needs. Agencies can feel proprietary about their individual data and may feel they are losing control of their information when a coordinated approach is initially developed. Mitigation strategies have been adopted by various states to meet these conditions, including education, training, and requesting participation and input from agencies which have helped to reduce this problem. In order for information to be developed by one entity and utilized by another, it must meet user standards and classification criteria, which often necessitates establishment of these criteria prior to development. Data confidentiality and restriction of usage by some entities is also a problem, but has been successfully addressed in design of these systems.

The benefits of GISs can often be long term for statewide planning and agency management and are not as easily documented as costs. Tangible benefits are shown for specific applications as well as better information to manage resources in general and provide site location, market, and environmental impact analyses for developments. Intangible

benefits include improved cooperation, communication and coordination between state agencies, federal agencies, local governments, and the educational and business communities. In addition, cost sharing projects with other entities have increased cost effectiveness of data base development and increased their usefulness to others beyond state agencies. Initial cost/benefit analyses are nonetheless difficult, and as a result, financing schemes and charge back systems have only recently been analyzed and developed as usage increased and competition exists for staff and system time. In general, states that have developed geographic information systems and resource centers appear to have considered them to be a sound investment for the future and successfully proven their value after implementation.

V. Technological Developments

A. Remote Sensing

Technological developments in remote sensing through satellite imagery, such as Landsat, and aerial photography have dramatically increased the resolution of data which can be visually displayed and used as a basis of a geographic information system. These resources can be extremely useful for analysis of land cover and resource utilization through time. It is anticipated that resolution up to one centimeter will be possible by 1990. Timely and historical visual information about a geographic area is often needed, thus it is important to inventory existing remote sensing efforts, identify future needs and resources, and prioritize, plan and finance needed work.

B. Measurement

New technological advances in surveying accuracy and methods have resulted in improved bases for systems development. In addition, new horizontal and vertical control networks are being established under congressional direction by the National Geodetic Survey of the National Oceanographic and Atmospheric Administration. These changes, commonly called NAD 1983, will result in coordinates based on an earth centered system. For Wyoming, this will result in an approximate southerly shift of 8 meters in latitude and 50 to 60 meters change to the west in longitude. This change will effect future cartographic products from the USGS and other coordinate systems such as state plane coordinates. Conversion programs from NAD 1927 to 1983 are available, however, the implementation of this change in Wyoming will be necessary in a coordinated fashion to help avoid confusion between the systems.

C. Computer Hardware and Software

Vast technological improvements during the last few years have enabled states to take advantage of integrated, automated geographic information systems. State and federal GISs are generally run on Prime, VAX, Data General, Intergraph or other minicomputer configurations. Microcomputers are used for some analyses, however, their size poses limitations for statewide data needs. Software for state geographic information systems is primarily ESRI's Arc/INFO, or MOSS, which is in the public domain and supported by Autometric, Inc. State highway departments are largely using Intergraph systems. Some states and federal agencies are using both MOSS and Arc/INFO, with technological improvements facilitating data compatibility and transfer between these and other systems. I have acquired promotional materials and talked with representatives of all three firms. In addition, when talking with various states and federal agencies, I have received comments regarding these systems and will be able to compile them in a final technological assessment of geographic information systems.

In addition to these systems, computer aided design (CAD) systems are often used for engineering applications for highway design and utility management. Other software in use includes econometric models that are attached to GIS systems, and database management systems which are used to index location-based information, such as INFO which forms a necessary part of Arc/INFO.

Future software improvements will be in the area of better conversion and access between systems as well as general upgrades. Perhaps the most anticipated hardware improvement will be the greater sophistication of optical scanners to improve data entry capabilities, but manual digitization will probably always be needed for some data. Hardware and software will always improve, but experts advise designing and implementing systems now as the technology is at a level of sophistication to be useful today with improvements serving to enhance future capabilities.

VI. Efforts Regarding Education and Training

One of the most important components of a project to improve the use of geographic information is an educational program and training effort. In terms of external training sessions, workshops and conferences, I have kept an active file of information that I have received and referred to interested persons. Three persons attended the Tenth Annual Pecora Conference on remote sensing in Fort Collins during August and

I have announced this and other sessions at meetings. Internal efforts have included educating State employees about my investigations regarding geographic information usage in other states and technological developments. I have also indexed materials collected during the last six months and have made them available to State employees for educational purposes.

Our first major training event was held on August 19, with over thirty-five state representatives in attendance. Two representatives of the State of Kansas were contacted by me and spoke at no charge to the State about geographic information systems, natural resource information systems and the approach used in Kansas. In addition, a former employee of the Bureau of Reclamation spoke about his use of a geographic information system for the analysis of irrigated agriculture in Nevada. Dick Hartman, State Planning Coordinator, opened the meeting and I provided an update of activities. I originally anticipated having a full rather than half day program with some more case studies and demonstrations, however, this kind of training can be provided in the future.

VII. Networking Resource

After talking with a variety of state, federal, and local officials, it appears that a variety of work is being conducted regarding geographic information data collection and usage, however, there is a need for greater communication and coordination. Virtually from the beginning of this project, I have been referring State and federal agencies to each other and providing assistance when possible. Approximately one meeting per month has been held since April which facilitates coordination and communication in addition to the specific objectives of the meeting. Federal representatives attended two meetings and provided information about their efforts and projects as they relate to Wyoming.

In my limited de facto role, I have referred federal, state and local agency representatives to each other and have also received a variety of inquiries. For example, I gathered relevant State agencies together to meet with the National Geodetic Survey about their new coordinate system. I also received an inquiry from Sheridan regarding photography provided by the State and provided a list of contacts in that regard. State agencies that have been faced with project development needs have inquired about activities in other states. I have been able to provide information about water management, hazardous waste, environmental and natural resource systems, etc.

VIII. Potential Demonstration and Pilot Projects

A variety of State agencies are working with geographic information, however, a few have made systems commitments and/or are potentially in need of sophisticated systems to meet their program objectives.

A. State Highway Department

The State Highway Department has recently committed to purchasing an Intergraph System as a Computer Aided Design (CAD) project. Digitization of design information is beginning now and the planning branch is investigating the purchase of an additional system for their needs. Commitments such as this represent expenditures in excess of one million dollars for complete implementation. This project can serve as both a resource for other state agencies and as a demonstration project for the use of advanced technologies.

B. Revenue and Taxation - Mass Appraisal System

A key component of a mass appraisal system is a geographically referenced and parcel identification system. Much manual work has been accomplished to delineate individual parcels within the State of Wyoming, however, the volume and changing nature of this data warrants automation of this database. A geographic information system is currently being investigated and potentially will be requested during the upcoming Legislative Session. Again, such a system would be a key basis for geographic information analysis for the State and local governments, as well serving as a demonstration project to educate other agencies.

C. State Engineer's Office - Big Horn Water Suit Project

The State Engineer's Office has been charged with developing an information base regarding the variety and quantity of water rights that exist in Division III. Given the nature of this information, the variety of sources with differing map displays and sizes, and the potential for individual and aggregate changes in decisions, a geographic information system is an obvious choice as a tool to provide and analyze needed information for this project. This office is currently investigating the potential of developing such a system for Division III and potentially using it as a pilot project to automate the remainder of the office's records. Given the importance of water as a major issue in the State of Wyoming, this project could provide an excellent basis with which to build other water related information and create a basis for overall water policy, management and planning needs.

IX. Financial Analysis

Within the State of Wyoming it is difficult to ascertain the amount of funds spent on geographic related information collection, development, usage, and reproduction. I have investigated the accounting system and tabulated total statewide expenditures in specific categories. However, many of these expenditures may or may not be related to geographic information, and it is extremely difficult to determine labor and support costs at this time. The only in-depth analysis I was able to find in another state was in Wisconsin. During their fiscal year 1975-76, the total of land record expenditures by all levels of government was approximately $17.00 per person or nearly 2% of total state expenditures. This report concluded that Wisconsin citizens were not receiving their money's worth, due to limited accessibility to data, questions about land and its use or ownership, duplication problems, data not meeting local needs, impossibility of integrating data, confidentiality, and separation in governmental units. A similar analysis could be conducted in Wyoming.

In terms of the federal government, a November 22, 1982, report by the General Accounting Office, found that during the fiscal year 1981, eleven federal agencies spent a total of over $45,000,000 to develop computer technology for their mapping programs. The study concluded that because these new techniques have not been adopted in a coordinated fashion, duplication has developed among the agencies and opportunities for savings had been lost. The study further reported that the lack of a central database available to federal users was the principal reason that agencies began their own single purpose, computer mapping programs. It stated that all eleven federal civilian agencies inventoried have computerized map information from the USGS's 7 1/2 minute series maps but this information is not compiled and accessible in a unified system. With federal agencies continuing to use different formats, codes, and standards, the USGS will potentially be unable to provide a unified data source without large capital expenditures. With this report being three years old, duplication, expenditures, and the need for a coordinated approach is greatly increasing with time. Much further analysis is needed of geographic information expenditures within the State of Wyoming in order to avoid increasing duplications of effort and expenditures while providing greater usefulness and cost effectiveness of information.

X. Historical Record of Project

A necessary component of any analysis and improvement effort is a historical record of activities. I have written

minutes of each meeting held in the State of Wyoming since I began the project approximately six months ago and have also compiled information about previous activities in the State. In addition, I have attempted to inventory information from other states, federal agencies, local governments and the private sector. All of the information that I have acquired from vendors, and useful contacts and databases have also been indexed to provide ease of accessibility.

XI. Initiation of Policy Development and Coordination Groups

In order for a project such as this to succeed and be of value, a multiagency task force or commission must make decisions in terms of analysis methodologies and recommendations for state action. As stated previously, I have been in close contact with relevant and interested State agencies in order to update them on my activities and gain their input. Previous meetings provide a basis and list of potential participants for both an executive level policy making group and support groups regarding specific applications, technologies and resources. Given the current level of geographic information activity, expenditures, and needs, it is appropriate for a group to be developed to at least initially serve as a communication and coordination focal point. Upon completion of needed analyses, specific groups can be charged with goals and objectives in order to improve the usage and cost effectiveness of geographic information within the State of Wyoming.

XII. Future Activities

In addition to completing the analysis of the above sections, specific activities are planned during the next couple of months. State Engineer George Christopulos has requested and is planning a meeting of relevant State agencies to hear about the National Geodetic Survey's new geodetic control system and the plans of the USGS in this regard. This meeting will probably occur in early October. We are also attempting to arrange a demonstration of a GIS project developed by the USGS and the State of Connecticut. The USGS is also interested in establishing a demonstration of a GIS project for a couple quadrangles in Wyoming. Such an effort will require much coordination between State agencies in order to input and utilize a variety of data sets.

During the last few months efforts have been made to hold a large State and federal information exchange meeting. This day long session will enable all State and federal agencies who are developing geographic information to explain their activities and serve as a basis for future coordination

activities. This meeting is planned for December 3 and will be sponsored by USGS, BLM and the State.

We are currently receiving responses to the Geographic Information Survey. After they are compiled and analyzed, a meeting of State agencies will be held to review the results and enable State agencies to make corrections. A follow up survey, oral interviews or other mechanisms will be needed to complete an audit of geographic information efforts and usage. This audit and further communication and training activities will be needed to plan and implement future coordination and cooperative projects with a thorough and systematic approach.

XIII. Conclusion

This progress report provides a summary of six months of informal investigation and activities to analyze and improve the usage and coordination of geographic information in Wyoming. With thanks to Phillip Harris, State Budget Director, I was able to spend some time as a Budget Analyst. I also dedicated personal time due to my commitment to the importance of this project. Countless hours have been spent by other State employees prior to and since I began this work.

Much has been accomplished during this six month period. Even though I have supported and initiated much of the current State interest in geographic information systems, I am truly amazed at the increasing level of interest and commitment felt by State employees and persons outside of State government. This support and a thorough analysis can ensure improved effectiveness of geographic information in the State of Wyoming.

Geographic Information Definitions
Lisa Warnecke, September 9, 1985

Information Systems

Information and data resources joined together in both a formal and informal manner to support the operational, managerial, and policy decision making processes of an organization.

State Information or Data Center

A service, clearing house and referral entity that exists to support the planning, development, management and protection of data generated by a state. Its purpose is generally to provide maximum availability and access to data, provide a multidisciplinary approach to agency data requirements and reduce overlap, duplication and data costs. A center can provide interagency, federal and local government coordination, data analysis and interpretation, multiagency databases, consulting, training, information about new technologies, and services to agencies and other outside state governments.

Geographic Information Systems (GIS)

An information system that can input, manipulate and analyze geographically referenced data by inputting tabular, map and remotely sense data and providing output in terms of maps, statistics and reports for a variety of combinations of data sets and scales for a single location or for the aggregate of a system. A GIS can summarize a large quantity of statistical, remote sensing and cartographic data from several different sources into a few documents and display information by a large number of different parameters while reducing "information pollution" for decision making and providing a visual representation of spatial patterns in addition to tabular and textual reports. An automated GIS uses computer technology for data collection, storage, retrieval, manipulation and display with extensive utilization of automatically generated remote sensing data but additionally relying on field surveys and some manual techniques.

Multipurpose Cadastre

A detailed, comprehensive record of land-related information organized at the parcel level, and referenced by a parcel identification number (PIN). Multipurpose cadastres may

include the same information as geographic information systems, but in greater detail. They are indexed by PIN with a reference frame or geodetic network, with a complete record of attributes as in a GIS and activity regarding the parcel including buildings, inspections, licenses, permits, zoning, etc.

Remote Sensing

The acquisition of information by a recording device not in physical contact with the object under study. Some examples include satellite imagery such as Landsat, and aerial photography provided by the National High Altitude Photography Program and custom photography. This data requires sophisticated interpretation and can become part of the basis and input to a geographic information system.